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REPORT

OF THE

BOARD OF SEWER COMMISSIONERS

AND

GEORGE E. WARING, JR.,

EXPERT ENGINEER,

ON THE INTERCEPTING SEWER,

MADE TO THE

HON. COMMON COUNCIL

OF THE

CITY OF BUFFALO,

MONDAY, SEPTEMBER 18th, 1882.

Adopted by the Council, October 2, 1882.

TOGETHER WITH THE

Act Creating said Board of Commissioners.

BUFFALO, N. Y.

HENRY NAUERT, Printer and Binder, 191 Main Street.
1882.



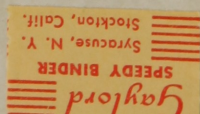
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CHAPTER 341.

AN ACT to create a Board of Commissioners of Sewers of the city of Buffalo, to define their powers and duties, and to provide means for the construction and maintenance of certain sewers in the city of Buffalo. Passed June 8, 1882, three-fifths being present.

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

SECTION 1. The city of Buffalo is hereby authorized and empowered to construct a trunk sewer from a point in Niagara river north of the water-works and south of Albany street to a junction with the Mill Race sewer, so-called, including a tunnel to be used as an outlet to said sewer under the Erie canal and Black Rock harbor, and also a connecting sewer from the well-hole in the westerly end of Bird avenue sewer to said tunnel.

§ 2. Immediately upon the passage of this act the Mayor of said city, by and with the advice and consent of the Common Council, shall appoint five persons Commissioners of Sewers of said city.

§ 3. Before entering upon their duties the said commissioners shall severally take the oath of office prescribed by section one of article twelve of the Constitution. The said commissioners shall hold meetings at the office of the Park Commissioners in the city of Buffalo. At the first meeting they shall select one of their number as chairman. A record shall be kept of all the proceedings of said commissioners. Subsequent meetings may be held at the call of the chairman, and said commissioners may, by resolution, fix the time for holding regular and stated meetings. Notice of all meetings shall be given by the clerk by depositing a notice addressed to each of said commissioners in the post-office at Buffalo at least one day before such meeting is to be held. A majority of said commissioners shall constitute a quorum for the transaction of business by them. None of said commissioners shall receive any compensation for his services, but shall be paid for all expenses incurred or expenditures made in the discharge of his duty, out of the funds by this act created. If a vacancy shall occur in the number of said commissioners by death, resignation, removal from the city, or otherwise, such vacancy shall be filled in the same manner as provided in section two of this act. Said commissioners, when organized, shall be known as "the Board of Sewer Commissioners of the City of Buffalo," and shall, as soon thereafter as practicable, submit to the Common Council of said city, plans and specifications for said sewers, including the route of the same, which plans, specifications and route shall be subject to the approval of said Common Council.

§ 4. Whenever the Common Council of said city shall have adopted plans and specifications for said work, including the line of route thereof, they shall, by a resolution to be approved by the Mayor and entered upon the journal of their proceedings, order such work and define the said route. And the said work shall be done by and under the direction of the said "Board of Sewer Commissioners of the City of Buffalo." The plans, specifications and route, when adopted, shall not be changed except on the recommendation of the commissioners and the approval of the Common Council.

§ 5. Said sewers and tunnel shall be constructed by contract; said commissioners shall advertise for proposals for constructing said sewers and tunnel, and furnishing material for the same, under one entire contract, or in parts or sections under several contracts, as they shall deem for the best interests of the

city, for a period of not less than ten days, in the official paper and in at least one newspaper printed in Boston, New York, Cleveland, Cincinnati, Chicago and St. Louis. The said commissioners shall require a bond of each person who shall submit proposals in such amount and with such sureties as they shall determine, to be submitted with such proposals, conditioned that the persons or person making such proposals shall enter into a contract for furnishing the labor and materials for and constructing such sewers and tunnel, or the portion thereof for which such proposals are asked and submitted, according to the plans and specifications, at his proposal or bid, and that he will furnish such security as said board shall require to be furnished for the faithful performance of his or their contract.

And said commissioners shall require any person or persons with whom they shall contract for doing said work or furnishing said materials, or any part thereof, to give sufficient security, to be approved by them, for the faithful performance of such contract or contracts. Said commissioners may reject any and all proposals and bids which may be made to them, and may contract with other than the lowest bidder for such materials and work, or any part thereof, and may re-advertise for the same. Said commissioners are hereby authorized to expend a sufficient amount of money to perform all the duties imposed upon them by this act.

If it shall be necessary to use, in the construction of said sewer, any lands owned by private individuals or corporations, said commissioners may purchase the same of such individuals or corporations, or may agree with them upon the terms upon which said lands may be used for the purposes of said sewers and tunnel. If said commissioners shall be unable to agree with any person or corporation upon terms at which any property may be purchased, or the right to use the same acquired, said commissioners may institute and conduct proceedings before the Supreme Court or the Superior Court of Buffalo, for the purpose of condemning said lands to public use. The said proceedings shall be commenced in the name of the Board of Sewer Commissioners of the city of Buffalo, and in the manner and according to the practice prescribed by the laws of the State of New York for appraising lands sought to be taken by railroad corporations. When said lands have been appropriated in said proceedings and the consideration therefor paid or deposited, the title thereto and the uses therein shall vest in fee in the city of Buffalo.

§ 6. Said board of commissioners is hereby authorized, with the consent and under the direction of the Superintendent of Public Works and State Engineer, to use a portion of the north side of the Main and Hamburg canal in said city of Buffalo, not exceeding twenty-five feet in width, for the purpose of constructing said sewer. Permission is further granted to lay a sewer in or along the towing-path of the Erie canal, in the city of Buffalo, from Bird avenue to Albany street, and in front of the Buffalo water-works, subject to the approval and consent of the Superintendent of Public Works and the State Engineer. The construction of said sewer upon said canal lands, and the tunnel under the Erie canal and Black Rock harbor, as authorized by section one, to be upon plans and specifications approved by the State Engineer and Surveyor and the Superintendent of Public Works. And the city of Buffalo shall, at its own cost and expense, maintain and keep said sewer, its walk and banks and said tunnel in perfect repair, as may be required by the Superintendent of Public Works.

§ 7. The said commissioners shall have authority to employ an engineer and such other necessary assistants as they may require in the discharge of their duties. Said commissioners may also call upon the Engineer of the city of Buffalo for assistance in the discharge of their duties. They shall keep a full record of their proceedings, which shall at all times be open to the inspection of the Mayor of the city of Buffalo, the President of the Common Council, or any committee appointed by that body. Said commissioners shall, upon the completion of their duties under this act, cause said record to be deposited in the office of the Clerk of the city of Buffalo.

§ 8. It shall be a misdemeanor, punishable by fine or imprisonment, for either of said commissioners, or any clerk, engineer, superintendent or inspec-

tor appointed by them, to be in any way or manner interested, directly or indirectly, in furnishing any material or labor for the construction of said sewer or tunnel, or in any contract which said commissioners shall make hereafter.

§ 9. If by reason of the construction of said sewer any of the property on the line of said sewer shall be benefited in any way other than in the matter of drainage, then such improvement shall be deemed a local improvement and said Common Council shall have the power to order an assessment upon the property deemed benefited thereby.

§ 10. For the purpose of defraying the cost of said sewers and tunnel and all expenditures authorized by this act, including the compensation to be paid and expenditures incurred in proceedings to acquire the title to a right of way under and across any property, the bonds of the city of Buffalo to such an amount as shall be necessary, shall be issued by the Mayor and Comptroller of said city; said bonds shall be known as "Buffalo Sewer Bonds," and shall be payable as follows: One hundred and fifty thousand dollars on the first day of August, eighteen hundred and eight-three, and one hundred and fifty thousand dollars on the first day of August of each and every year thereafter until the whole amount of bonds issued under the provisions of this act shall be paid; said bonds shall bear interest at an annual rate not to exceed five per cent., payable semi-annually from date, at such place as said Common Council shall designate. They shall not be negotiated at a less sum than par value, including interest from date, nor until proposals for the same shall have been invited by public advertisement in such a manner as the said Common Council shall direct. All moneys borrowed by said city upon the security of said bonds, and all moneys raised by general tax for the benefit of the Trunk Sewer Fund, as hereafter authorized, shall be paid into the treasury of the city and shall be used for the purposes authorized by this act, and for no other purpose whatsoever, and shall only be paid out of the treasury by warrants drawn by direction of the Common Council upon said fund. All warrants drawn upon said fund shall be drawn by direction of the Common Council of said city upon the estimate and recommendation of the commissioners appointed by this act and at such times and for such sums as they shall recommend. The Comptroller of said city shall include in his estimate of the amount necessary to be raised by general tax to carry on the city government for the year one thousand eight hundred and eighty-three, and for each year thereafter, a sum sufficient to pay the interest on all of said bonds outstanding, and to pay the principal of so many of said bonds as shall become due on each of said years, and said Common Council shall confirm said estimate and cause the said sum to be raised as a portion of the general tax of the year in which said estimate shall be submitted and confirmed. The proceeds of said tax shall be applied to the payment of said bonds and the interest thereon, and to no other purpose whatsoever. The Treasurer and Comptroller of said city shall cause to be opened in their respective offices an account to be designated "The Trunk Sewer Account," to which all moneys paid into the treasury, under the provisions of this act, shall be charged, and to which all moneys paid out by said Treasurer upon warrants drawn against said fund shall be credited. The interest upon the bonds hereinbefore authorized, and which shall be issued pursuant to the authority herein granted, accruing prior to the year one thousand eight hundred and eighty-three, shall be paid out of any moneys in the treasury which may have been realized by the sale of lands owned by the said city.

§ 11. Any surplus of the proceeds of such bonds remaining after payment of the costs and expenditures incurred by the provisions of this act shall remain to the credit of such sewer account, and shall be paid out only on warrants issued in payment of expenses incurred in maintaining said sewer. The Comptroller shall annually, after the completion of said sewer, include in the estimates submitted by him to the Common Council a sum sufficient to defray the cost of maintaining said sewers and tunnel, which sum shall be included in the general tax of that year.

§ 12. Chapter thirty-eight of the laws of eighteen hundred and eighty-one, entitled, "An act authorizing and empowering the Common Council of the city of Buffalo to use a portion of the Main and Hamburg street canal in said

city for the purpose of constructing a sewer and for leave to pass under the Erie canal," is hereby repealed.

§ 13. This act shall take effect immediately.

STATE OF NEW YORK, }
OFFICE OF THE SECRETARY OF STATE. } ss:

I have compared the preceding with the original law on file on this office, and do hereby certify that the same is a correct transcript therefrom and of the whole of said original law.

[L. s.] Given under my hand and the seal of office of the Secretary of State, at the city of Albany, this 9th day of June, in the year one thousand eight hundred and eighty-two.

JOSEPH B. CARR, Secretary of State.

REPORT

OF THE

Board of Sewer Commissioners.

To the Honorable, the Common Council of the City of Buffalo :

The Board of Sewer Commissioners of the city of Buffalo, pursuant to the provisions of Chapter 341 of the Laws of 1882, submit their report.

The commissioners, after their organization, examined with care the plans and route for a trunk sewer as heretofore proposed, and having familiarized themselves with the details of those plans they employed Mr. George E. Waring, Jr., of Newport, R. I., a sanitary engineer of experience and eminence, to aid them in their endeavors to select a route and plan for an intercepting sewer which should fill the requirements of the future as well as the present, at an expense less than that called for by the former plans.

Mr. Waring came to this city, and having, with the commissioners and the City Engineers, and others, gone carefully over the whole ground, made his report, accompanied with plans and provisional specifications which are made the basis of this report, and which are herewith submitted to the Council.

By the act of the Legislature under which this board is organized, authority is granted to construct a trunk sewer from a point in Niagara river north of the water-works and south of Albany street, to a junction with the Mill Race sewer, including an outlet under the Erie canal and Black Rock harbor into the Niagara river.

We submit the following as the route for the said trunk sewer, viz:

Beginning at the Mill Race sewer in Swan street, following the line of Swan street to the Terrace, through the Terrace to Court street, through Court street to Fourth street as far as Porter avenue, thence along the slope of the Front to the bank of the canal, and along the bank of the canal to a point near Albany

street and to the south thereof, and thence under the Erie canal and Black Rock harbor out into the Niagara river.

The route we submit is substantially the same as that proposed in the former plans, between Albany street and the Terrace. We have decided upon the Swan street line as the most practicable, and cheaper than the other routes. We do not favor the line through the lower Terrace and the bank of the Hamburg canal, for the reason that it is more circuitous and very much more expensive, and because it is doubtful if with the utmost care and skill it could be so constructed upon the bank of the canal and below the water line, as that the canal water would not leak into it. This route, too, would involve the payment of land damages to an unknown amount, and thus increase the cost of the sewer.

We are advised that the Exchange street route is not practicable owing to the character of the soil and the level of the land.

Borings in Seneca street have developed a number of quicksands which would render construction expensive and difficult, and this combined with the fact that this street is so extensively used for active business through its whole length that the excavation might be considered onerous to business interests, has decided us not to select that route.

Swan street beyond Ellicott is a residence street, and the open cut which will occupy the middle of the street will not so seriously inconvenience any one as to be an objection. We propose to construct the sewer from the Terrace to a point east of Michigan street, under Swan street, in tunnel, thus avoiding any interference with travel between those points; beyond that, easterly, the open cut will be but 15 feet wide, and by proper regulations to be strictly enforced upon the contractors, a clear passage for vehicles will be maintained on each side of the cut.

By frequent borings in Swan street it appears that the soil is of clay, which not only insures easy working in the tunnel, but an excellent and secure bed for the sewer.

We submit as a general plan that the sewer shall be circular in form, and eight feet in diameter from the Mill Race sewer to Albany street, and that the outlet under the canal and Black Rock harbor shall be eight feet six inches in diameter.

There will be flushing inlets from the Hamburg canal, through Hamburg street, through Chicago street and through Washington street, and there will also be flushing inlets from the Erie canal at Peacock slip, Genesee street, Wilkeson slip, Georgia street, Virginia street, Pennsylvania street and Porter avenue.

These inlets will be provided with automatic gates which will close when the water in the trunk sewer during heavy rain-falls shall have reached a certain point.

The flushing inlet in Washington street would be in tunnel from a point south of Exchange street, thus avoiding any material obstruction of travel.

The present sewers which lead into the Hamburg and Erie canals will discharge themselves into this trunk sewer through a cup-like arrangement as shown by the drawings herewith submitted, and being continued on as at present to the canals will operate and be used as vents and to carry off such excess of storm water as will not be carried off by the trunk sewer.

The bottom of the sewer in Swan street will be at the same level that it would be if placed in Seneca street or on the bank of the canal, and being below the water line of the canal, ensures a constant flow of water into the sewer from the canal, thus answering the double purpose of flushing the sewer and constantly changing the water in the canal.

We have given much thought and our most careful consideration to the size of the sewer, and in submitting to you one eight feet in diameter in place of one twelve feet in diameter, we feel confident that we are providing ample capacity for the sewerage of all the territory to be drained in the future. It is beyond controversy that a sewer of even less size would, for a great many years and for a vastly increased population, receive and dispose of all the sewerage proper, and it is a simple question of how much of the storm water shall be intercepted.

The sewer of twelve feet in diameter as heretofore proposed did not take all the storm water, but was provided with overflows into the canals. The sewer we propose will not take as much storm water, but will take all of the water which falls in ordinary rains, and it is believed that the overflow into the canals would not occur many times a year. By the ingenious arrangement of Mr. Waring, as

shown in the drawings, the filth in the various sewers would be carried off down the trunk sewer by the first rush of the storm water, and when the overflow point is reached, the water which will reach the canals will be so nearly pure that we feel perfectly assured it would not materially contaminate the canal water. In addition to this, as soon as the storm has ceased the current of water will flow from the canal into the sewer and the water thus drawn out will be replaced with fresh water from the slips.

That portion of the city lying south of Swan street and north of the Hamburg canal will continue to drain into the existing sewers, but our plans contemplate emptying the sewers in Seneca, Carroll, Folsom, Exchange and other streets into the flushing inlets in Washington, Chicago and Hamburg streets, and by proper methods thus diverting the sewerage from the canal to the trunk sewer.

It will be observed that in Mr. Waring's report to our board he recommends a branch of the trunk sewer to pass through Court street, Niagara square, and by tunnel under Lafayette square, and out Broadway to Herman street, thus intercepting the higher watershed and avoiding the necessity of the sewerage of the city above Broadway traveling down to Swan street.

While we think most favorably of a branch sewer through Broadway or Genesee street to flow into the trunk sewer, and believe that it is needed by that portion of the city, yet the city has no power by the law under which we are acting to construct such a branch, and we therefore submit no plan or route for it.

The city, by the act of the Legislature, is authorized to construct a connecting sewer from the well-hole in the westerly end of the Bird avenue sewer to the outlet of the trunk sewer. We do not submit any route or plan for such a sewer, and we do not recommend its construction, for the reason that we are of the opinion that a better route can be adopted than that defined by the law as it now stands, and inasmuch as it could not be constructed till the outlet is completed, we recommend that no action be taken upon this connecting sewer for the present.

The board has caused an estimate to be made of the probable cost of the trunk sewer constructed upon the plan and route herein submitted. This estimate was made upon the basis of those con-

tained in the report of City Engineer Rogers under date of April 3, 1882, and is as follows:

	Price.	Quantities.	Amount.
Excavation, cubic yards, clay.....	\$1.00	106,798	\$106,798
Excavation, cubic yards, rock.....	4.00	39,600	158,400
Brick masonry, yards.....	9.50	22,211	211,004
Concrete, yards.....	4.00	6,856	27,424
Lumber, feet, B. M.....	40.00	144,000	5,760
Iron work, sewer connections, etc.....	....	.....	85,280
Tunnel, lineal feet.....	....	2,800	74,704
Street re-paving.....	....	.....	30,000
Outlet under canal.....	....	.....	65,000
Total.....			<u>\$764,370</u>

The estimate for the Swan street line under the old plan was \$1,406,782.

We submit herewith the report made by Mr. Waring to this board, together with maps, profiles and drawings and provisional specifications. We have not deemed it advisable to incur the expense at this time of full working drawings and specifications. Should your body adopt our plan and route we will at once cause all necessary drawings and specifications to be prepared.

Respectfully submitted,

D. C. BEARD.
JACOB SCHEU.
MICHAEL NELLANY.
GEO. B. MATHEWS.
GEO. GORHAM.

Dated Sept. 18, 1882.

NEWPORT, R. I., August 17, 1882.

To the Board of Sewer Commissioners of the City of Buffalo:

GENTLEMEN: In compliance with your instructions I have examined the condition of your canals and the circumstances in connection with your present and future sewerage which should influence the construction of the intercepting sewer needed to withhold the putrescible organic matter by which the canal water is now made foul. Concerning the importance of constructing such a sewer I need add nothing to the convincing arguments with which your community is already so familiar. Your citizens must recognize, to a greater degree than a casual visitor can do, the full bearing in this

case of the demands of salubrity and of common decency. The question of the day with Buffalo is not at all as to the policy of instituting the proposed reform, only as to the best means for securing it.

I have under your guidance made an examination of the whole ground; I have received much information from your local engineers; I have examined with care the excellent contour map of the city, and I have endeavored to regard the subject from the point of view of the experts who have already reported upon it. With this preparation I venture to submit my report.

The theory on which the earlier recommendations have been based commands full approval. There can be no more perfect means devised for securing the end in view than to establish a strong, active and constant current, in a channel specially provided for the purpose, sufficient to wash into Niagara river below the intake of the water-works, those foul substances which, under present conditions, are deposited in the canals. In its ability to maintain such a current, Buffalo is especially favored. The means for most copious constant flushing and the absolute solution of the usually difficult question of disposal afforded by your canals and your river, are, so far as I know equaled in no other American town. Filth delivered into the head of the sewer will speedily be shot into the river and practically annihilated. Mr. Chesbrough and Mr. Lane have both accepted this solution of the problem and have demonstrated its completeness.

In the details of their application they differ but slightly, and for the purposes of this discussion it will be well to confine attention to the later of the two projects, which provides for a circular sewer 11 feet and 11 inches in diameter, discharging at Albany street at a grade which brings the crown of its arch 3 feet above the ordinary level of the river. At its upper end, at Hydraulic street, it is equal to a circle 9 feet and 8 inches in diameter, and the crown of its arch is there about 6 feet above the ordinary level of Niagara river at Albany street. Its theoretical dead water line is 1 foot and 4 inches above its invert at its upper end and nearly 6 feet at its lower end. It is arranged to receive a copious inflow from the canal of which the ordinary level is 4 feet and 9 inches above this line. This inflow would establish the desired current.

The dry weather flow of the sewers would add something to the volume thus taken from the canal, and deposits at the bottom of the sewer need not be considered. Should such deposits form, they will be safely buried under a living current, and they would be removed with each storm. In short, the proposed sewer can safely be accepted as efficient and satisfactory in its operation.

Reasonable criticism of the proposed work is confined to its cost and to the time which must be occupied in its construction. The sewer is intended to take all of the dry weather flow of the city's drainage and a considerable amount of storm water. As the purpose of its construction relates solely to the withholding of filth from the canal, it is not, in my judgment, of unquestionable propriety to spend so much money and to postpone the benefit to the city for so long a time as would be required for its construction, for the sake of keeping out of the canal a large volume of surface water whose introduction would in no case be serious in its effect. Were it proposed to intercept all of the storm water the conclusion would at least be logical; but as all very heavy storms would cause the sewer to overflow into the canal, it seems prudent to consider the efficiency of the interception of a less amount, including the early flow of severe storms, bearing the foul deposits of the sewers, and the whole flow of light rains. There is, of course, a certain advantage in intercepting as much of the storm water as possible; but as storm water contains during long rains less and less organic matter as its flow continues and increases, there comes a point at which its interception costs more than it comes to. I think this point is passed in adopting an intercepting sewer for Buffalo which calls for such an extravagant outlay as the one in question. Were it necessary to depend on large volumes of storm water to flush the intercepting sewer itself—as it generally is—the case would be different. But here we do not in the least care for the flushing of occasional storms; we have in the inexhaustible supply of the canal more than we need for such constant flushing as will keep the sewer always clean to its invert, if it be of only ample proportions.

It would seem, therefore, that, while the sewer proposed by the two boards of experts would, undoubtedly, establish a current sufficient to remove the filth of the city's drainage, as good a practical result may be obtained with a much smaller outlay. It is, no

doubt, true that the prosperity of the city is so great that it should not hesitate at any expenditure needed to secure most perfect sanitary conditions, but there will still remain an ample field for profitable investment in sanitary works after the intercepting sewer shall have been finished. Economy—not parsimony—should control each step.

Governed by the foregoing considerations, I recommend such a modification of the intercepting sewer proposed by the two boards of experts as will, in my judgment, secure the desired result at much less cost and in a shorter time.

Description: I recommend the construction of a circular sewer, eight feet in diameter, beginning at the Mill Race sewer in Swan street, following the line of Swan street to the Terrace, through the Terrace to Court street, through Court street to Fourth street as far as Porter avenue, thence along the slope of the Front to the bank of the canal and along the bank to a point near Albany street, whence its course and grade are changed to carry it under the canal and harbor and into the river.

From its intersection with the Mill Race sewer to the point where the depression to go under the canal begins, near Albany street, the inclination of the sewer will be 1...4656. The walls of the sewer should be, uniformly throughout its whole length, about thirteen inches thick (three rings). In passing the water-works some special provision, such as that indicated in the former specifications, will be necessary. As this part of the sewer will be laid in rock-cutting, in addition to the iron casing, some special means will be required for intercepting water flowing through seams of the rock which may have become contaminated by leakage from the sewer at a distant point.

The invert of the sewer at Albany street will be 10 feet below the city datum. At its head the invert will be 5.18 feet below the city datum.

At its upper end the invert of the sewer will be 2.43 feet below the ordinary level of the water of the Hamburg canal. Flushing water may be admitted from the canal in sufficient volume to establish a flow about 2.25 feet deep, and this depth of flow can be substantially maintained throughout the whole length of the sewer by frequent admissions of canal water along its course.

The sewer would intercept all of the sewers which now deliver into the canals throughout its whole course, and it may be made to receive by inexpensive iron siphons under the Hamburg canal the foul wastes of the industrial establishments on and near its south bank.

The sewer may be regarded as complete as described above, but I recommend that that portion of it lying above the junction of Court street and the Terrace be regarded as one branch of the intercepting sewer, another branch being constructed as described hereafter from this intersection of Court street and the Terrace to the corner of Broadway and Herman street.

The special appliances needed will be the connections for the reception of the flow of the intercepted sewers and the connections for the admission of canal water, with valve gates to close automatically when the flow of sewage rises higher than the water in the canal. The continuation of the intercepted sewers will serve as ventilators and as overflows, relieving the main of its air as its water rises, and delivering into the canal so much of the storm water discharge as cannot be intercepted.

The capacity of an intercepting sewer is subject to material reduction by the amount of involved air carried into it with the rapid flow of intercepted sewers of steep inclination. In order to secure the full effect of the work it will be necessary at points to adopt means for the escape of this air before the flow enters the main.

The tumbling bay and tunnel under the canal, proposed by the first Board of Experts, was properly criticised by their successors. All such devices, leading to a disturbance of the flow, are objectionable and wasteful. The sewer should be carried under the canal by a gradual depression of the main line and on a course of easy reversed curves with only such slight enlargement of its diameter as may be needed to compensate for the changes of direction, reducing the velocity of flow as little as possible.

Capacity: Although less than half as large as the Construction previously recommended, this sewer is a large one and its capacity is very great.

I have submitted my project to W. R. Hutton, Esq., Consulting Engineer and eminent hydraulician, and have received from him the following estimate of the rate of discharge that will be secured:

Assuming the sewer to receive the intercepted streams at its crown, with no additional head, the capacity will be:

At Hydraulic street, 192.2 cubic feet per second.

At Michigan street, 207.8 cubic feet per second.

At Court street and the Terrace, 230.0 cubic feet per second.

At a point between Virginia street and Carolina street, 249.6 cubic feet per second.

At Porter avenue, 301.0 cubic feet per second.*

With the intercepted streams entering man-holes 6 feet above the crown of the sewer and maintaining this additional head, as they would do before overflowing into the canal, the capacity will be:

At Hydraulic street, 244.0 cubic feet per second.

At Court street and the Terrace, 308.0 cubic feet per second.

At Porter avenue, 421.0 cubic feet per second.

Supposing a population of 500,000 to occupy that portion of the city draining to the intercepting sewer above Court street and the Terrace, with a daily production of sewage of sixty gallons per person, and supposing one quarter of the daily flow to reach the sewer in three hours, this maximum flow would be 92.8 cubic feet per second, leaving a margin for the admission of 137.2 cubic feet of storm water per second, which margin would be increased during the hours of least flow to over 200 cubic feet per second.†

With an interception under a head of six feet, which is entirely feasible, these storm water margins would be increased to about 215 cubic feet per second and 280 cubic feet per second respectively.

It seems unnecessary to provide for a greater population for the city than would furnish 500,000 residents for this part of its area. It is to be further considered that a very large portion of this area is so nearly level that its surface water will reach the sewer slowly and very incompletely, and that much of it is so low that its surface water will not reach the sewer at all.

All the sewer flow during light and long continued rains will be intercepted, and only a portion of the flow during more severe storms, and this not the earlier and fouler flow, will reach the canal.

The nearer we approach to the outlet of the sewer the greater will be the capacity. The steeper local sewers north of Court street

* A recent gauging of all the sewers to be intercepted showed a total dry-weather flow of only 11.9 cubic feet per second.

† By the empirical formula of Julius Adams, Esq., C. E., the capacity of the sewer at Albany street would be 294.6 feet per second.

will have been washed clean and their foul discharge will have gone into the river before the volume coming from the upper end of the main will so occupy it as to force them to overflow into the canal.

Long before the full capacity of the sewer can be required for necessary interception, a radical change will have been made in the character of the local sewerage and street paving and street cleaning of the city, so that the need for intercepting storm water in the interest of the purity of the canal will have mainly ceased.

Incidentally, it may be proper to state here my own conviction that the foul sewage of the city must before many years be removed through sewers from which storm water will be entirely excluded. The local storm water sewers will then be relieved of the filth which now accumulates in them in dry weather, and during rains their flow will contain comparatively little impurity. The discharge of the house sewers will be always far within the cleansing capacity of the flushing current from the canal.

With a view to a possible future need for a greater capacity in the main sewer than would be furnished by a simple eight-foot culvert, I have considered a future modification of the outlet, using the head of Black Rock harbor on the principle of the jet pump. This can be made effective in increasing the flow in the sewer below the Terrace.

I recommend that above the junction of the Terrace with Court street the intercepting sewer be built in two branches. There is no good reason why the sewage of a large and densely peopled portion of the city should descend to the level of the upper end of the sewer and follow the longer course thus required. The suggestion has been made to intercept the sewage of the higher land by a branch located on Genesee street. The desired effect would be much more completely secured by carrying this branch intercepting sewer at a lower level. I suggest for the consideration of the commissioners an intercepting sewer delivering into the main where it turns out of the Terrace to go down Court street, following the line of Court street to Broadway, and running out Broadway to Herman street. A sewer laid on this line would begin at Herman street with a depth of 10 feet. Its least depth, at Emslie street, and near Jefferson street, would be 8 feet, and its average depth where built in open cutting would be about 12 feet. For a distance

of 1,450 feet under Lafayette square it would be built in tunnel. I have estimated that below Michigan street this intercepting sewer would require a capacity of discharge equal to about one-quarter of the capacity of the main sewer at the point of junction. This would be given on the grade adopted—1..1578—by a circular sewer 5 feet in diameter. The diameter might be reduced to 4 feet and 3 inches between Michigan street and Jefferson street, and to 3 feet and 3 inches between Jefferson street and Emslie street, and to 2 feet and 3 inches from Emslie street to Herman street. After reaching Niagara square a much steeper grade would be necessary, and, in order to prevent too great a velocity of flow, the sewer should be so constructed as to prevent acceleration.

With such interception at Broadway, the amount of sewage discharged into the main sewer above Court street, even including the ordinary storm water discharge of the Mill Race sewer, might be carried away with a less diameter than 8 feet. But with the inclination that it is necessary to give to the main sewer in order to admit an abundant flushing supply from the Hamburg canal and to intercept the foul sewage of the lower districts, a sufficient velocity to keep the sewer clean calls for a diameter of 8 feet. The extra capacity of this sewer will also be serviceable in increasing its ability to intercept heavy storm floods coming through the Mill Race sewer, which is likely to remain for some time to come more than ordinarily foul.

Probably the interception at Broadway will limit the necessity for resorting to the additional head of 6 feet to the district below the junction of that intercepting sewer, if it is ever required even there.

Location: I have given careful attention to the bearings of the arguments in favor of and against the different locations that have been suggested:

The north bank of the Hamburg canal.

A route through Seneca street and the Terrace.

A route through Swan street and the Terrace.

My opinion is very decidedly in favor of the Swan street line. It is to be understood, of course, that whichever route is selected, the level at which the sewer is laid will be substantially the same, and that it will intercept as wide an area if laid in Swan street as

it would if laid at the bank of the Hamburg canal. Opinion on this subject should be controlled by the following considerations: The line along the bank of the Hamburg canal will necessarily be expensive both in the matter of right of way and in the obvious difficulties in the construction of work at that point below the level of the canal. The uncertain difficulties of working in such a locality would require a prudent contractor to add to his estimate a very large margin for insurance. The Seneca street route, though much easier, passes through several seams of quicksand, which would certainly increase the expense of work materially, and it would introduce uncertainties which must also be taken into account in estimating. Another objection to this route, more fancied than real, relates to the obstruction of the street during the execution of the work. The Swan street route, as indicated by frequent soundings, seems to escape quicksands entirely and to offer the most certain basis for estimate and the least obvious difficulty. From a point east of Michigan street to the Terrace it would be built in tunnel, so that the traffic of the street would be in no wise interfered with between these two points. From Michigan street to the head of the sewer at Hydraulic street the work would have to be done in open cut; but not more than 400 feet in length would need to be opened at any one time. The cut for an eight-foot sewer need not be more than twelve feet in width in the middle of the street, and the excavating apparatus used, straddling the cut, would stand on a footing occupying not more than fifteen feet in the middle of the street, leaving an ample passageway at each side. At no time would there be earth or other material deposited on the street outside of the fifteen feet reserved, all earth excavated being dumped on the completed structure or delivered by shutes into carts for immediate removal.

The exact course of the sewer from Hydraulic street to the outlet at Albany street is laid down on the map accompanying the complete profile.

At Hydraulic street it would be connected with the direct course of the Mill Race sewer, which sewer would be provided with sufficient overflows near its crown, delivering through its present extension to the head of the Hamburg canal.

The intercepting sewer being located in Swan street, some means must be adopted for carrying to it the dry-weather flow of the district between this street and the Main and Hamburg canal. This may be done without modifying the present local sewerage and drainage of this district by intercepting the present sewers with sewers parallel to the canal, and as near to it as convenience in working will allow, which shall connect them with the flushing inlets described below. By this means all of their flow, except during heavy storms, will be carried into the intercepting sewer, and such of them as deliver below the level of the canal will carry a current of canal water toward the main sewer.

It is, however, to be recommended that this district, and the manufacturing establishments south of the canal, be provided with a separate system of sewers to carry all of their foul flow to the intercepting sewer.

Flushing: I have provided the following flushing inlets for leading the water of the canal into the sewer with a view to maintaining as great a flow as possible throughout its whole length.

At Hamburg street, Chicago street, Washington street, Peacock slip, Genesee street, Wilkeson slip, Georgia street, Virginia street, Pennsylvania street, Porter avenue.

Present and future efficiency of the intercepting sewer:

As before stated, I believe that for a long time to come, and probably for all time, the sewer above described will answer every desirable purpose that it is worth while now to provide for. I have arranged for the admission of so much of the flow of every sewer along the route as can find room in a channel having an average capacity of discharge of 125,000 gallons per minute. If the inlets from the canal to the sewer were not protected, there would be a discharge of sewage into the canal whenever the flow line in the sewer rose higher than the level of the canal water. Such outflow must be prevented by simple swinging gates opening or closing with the current. Their effect would be to retain in the sewer, until the point of overflow at the crown is reached, all that comes to it, causing it to discharge to its full capacity.

It seems to be a controlling argument against the construction of a more costly sewer that any additional future capacity that may be required may be secured by devices of no great cost, whose

application may be postponed until the need for them is demonstrated. It will not be questioned that, with an intercepting sewer on Broadway, the main sewer from Hydraulic street to Court street will have ample capacity for any duty that it may be called upon to perform. Greatly to increase the capacity of the sewer from the Terrace and Court street to the outlet, the following additional methods may be adopted:

1. Raising the overflow points at the intersection of the different tributary sewer lines as much as the steep grades of that part of the city will allow without going too far back in the streets, say, for example, six feet at each point of intersection, thus bringing an additional head of six feet to bear on the flow of the sewer.

2. Carrying the outlet to a distance from the bank of the river, delivering into a swift current with the additional aid of the head of Black Rock harbor on the principle of the jet pump, and making a proper arrangement of inlets to prevent the admission of air at man-holes near to the outlet, it will be possible greatly to increase the discharge.

Bird Avenue Sewer: I have given much attention to the very important question of the interception of the Bird avenue sewer, and have considered carefully the project for delivering the sewage of nearly the whole of this district through the State ditch to Cornelius creek. This project is a feasible one, but it would be very costly, and unless expensive outlet works were constructed at the mouth of Cornelius creek, I should apprehend serious inconvenience in that locality. In any case, Cornelius creek for a long distance back from the river has substantially no fall, and it would probably be found necessary to cause that portion of the sewer to work under a head, with the certainty of a considerable deposit occurring in the intervals between storms. One of the arguments in favor of this outlet has been that it would afford the State Asylum a more satisfactory means for getting rid of its foul wastes than it now has. It seems clear that as the roof water and yard water of this establishment may safely be delivered over the surface of the ground into the depression leading to the State ditch, it is not important to consider anything more than the foul outflow. This can be provided for by a very simple pumping outlet of little head, so as to afford complete drainage for the establishment at a small

fraction of the cost of carrying it independently, or in combination with the city, through a sewer to Cornelius creek.

I suggest that the necessary relief may be obtained by the interception of the Bird avenue sewer above the drop near the canal where the head is sufficient to give a rapid flow to Albany street. This would constitute an economical, and, I think, entirely satisfactory remedy for the serious existing evil.

The Interior Sewerage of the City: It is no part of the immediate duty with which I am charged to discuss any project for the improvement of the interior sewerage of Buffalo, but it is proper in this connection to call attention to the fact that the work with the execution of which you are now entrusted is, aside from the important duty of purifying the canals, only a means to an end. It is well understood that in all work of sanitary drainage the immediate effect on the health of the population is in direct proportion to the nearness of the improvement to the habitation. That is to say: the greatest influence on the health of a family comes from the soil pipes and waste pipes and other appliances for the removal of waste matters within the house. Next to this comes the condition of the drain leading from the house to the sewer. The sewer itself being more remote, has the least direct influence, and the manner of final disposal is apt to have a much greater bearing on the question of decency than on that of the general health of the whole people, affecting those who live in the immediate vicinity of the outlet to a much more marked degree than those living near the centre of population—affecting sometimes those who live far enough down the course of the outlet stream to receive the exhalations of the sewage after it has become thoroughly putrid more than those who live about the immediate outlet within the city.

It follows, as a matter of course, from the hap-hazard, unguided way in which the local sewerage of Buffalo has been carried out, that it can hardly be said to constitute a system at all. The importance of providing, at an early day, some complete and comprehensive plan on which to remodel the sewerage of the closely-built portion of the city can hardly be over-estimated. What plan should be adopted in this connection I have not been called upon to consider. That some radical and universal improvement will soon become necessary cannot be doubted.

The improvement of street surfaces and the removal of street dirt by some other means than leaving it to be washed into sewers by rains is hardly less worthy of the consideration of the public.

When a thorough reform shall have been established concerning these two matters, and not until then, the full benefit of the present proposed outlay will be realized. When the indicated improvements shall have been perfected, I think it more likely that the intercepting sewer recommended above will be found to be unnecessarily large than that it will be found to be too small.

Appended hereto I forward plans and provisional specifications for the construction of the intercepting sewer. Before working specifications can be prepared which shall be reliable for estimating the cost of the work, it will be necessary to procure considerably more detailed information than now exists, and to do an amount of work in the preparation of plans for inlets, storm overflows, etc., etc., for which it seems unnecessary at this stage of proceedings to increase your outlay.

Respectfully submitted,

GEO. E. WARING, JR.

PROVISIONAL SPECIFICATIONS FOR THE CONSTRUCTION OF AN INTERCEPTING SEWER IN THE CITY OF BUFFALO.

Construct a main sewer eight feet in interior diameter, with walls of three independent rings of brick work (four inches each), laid in cement mortar and rendered with a coating of pure hydraulic cement outside and inside.

The sewer to be built on the lines shown on the map of its course, attached to the profile of the sewer.

The sewer to be single from the junction of Court street and the Terrace to the outlet at Albany street, as shown; from the junction of Court street and the Terrace upward to be constructed in two branches, one following the Terrace and Swan street to Hydraulic street, the other following Court street and Broadway to Herman street.

The Swan street branch is intended for the interception of the flow of the Mill Race sewer and of the sewers of the whole district lying between Broadway and the Hamburg canal and Mill Race sewer; also for the discharge of the waste of manufacturing establishments on the south side of the Hamburg canal; also for the

constant withdrawal of a large volume of water from the Hamburg canal to be replaced by fresh water from the lake.

The Court street and Broadway sewer will intercept at a higher level the sewers draining nearly all of the remaining territory between the Hamburg canal, Fillmore parkway and High street, as far west as Main street and east of Georgia street.

The Swan street branch of the main to be of the same size and construction with the main below the intersection of the Broadway branch.

The Broadway branch to be five feet by five feet, of the form and construction shown in the plans, from the junction with the main in Court street to Niagara square; five feet in diameter from Niagara square to Michigan street; four feet and three inches in diameter from Michigan street to Jefferson street; three feet and three inches in diameter from Jefferson street to Emslie street; and two feet and three inches from Emslie street to Herman street.

It is to be built with a double four-inch wall from the Terrace to Emslie street, and with a single four-inch wall from Emslie street to Herman street.

Each sewer crossing the lines of the main intercepting sewer or either of its branches to be so connected therewith as to deliver into it so much of its flow as the said intercepting sewer is capable of receiving, but so arranged as to carry on beyond the intercepting sewer, and to the canal, any excess of its flow which cannot gain admission to the intercepting sewer, or any excess of flow in the intercepting sewer itself. In other words, the sewers to be intercepted are to continue their course to the canal with a capacity for carrying so much of their own flow as cannot be admitted to the intercepting sewer, and so much of the excessive flow of the intercepting sewer as seeks relief at these points of connection.

Inlets to carry canal water to the sewer are to be constructed on Hamburg street, Chicago street, Washington street, Peacock slip, Genesee street, Wilkeson slip, Georgia street, Virginia street and Porter avenue. The inlet on Hamburg street will receive its supply from the present culvert of the Mill Race sewer at the head of the canal. The floor of this inlet channel will be at grade, 5.00, and it will run to the grade of the invert of the sewer. It will be constructed with three broad culverts lying side and side, having a

total area below grade, 2.75, of not less than 40 square feet. The other inlets will be similarly constructed of single culverts, having each an area of not less than 20 square feet below grade—2.75. All of these inlets will be curved on a radius of not less than 40 feet, delivering in the direction of the flow of the sewer. Each inlet will be provided with a swinging gate opening or closing with the current, to be constructed of galvanized cast iron, with gun metal seatings and hinges, and closing against a frame of the same materials.

All existing sewers crossing the line of the proposed intercepting sewer to be cut off sufficiently far back to enable them to deliver their contents into the top of the intercepting sewer. The connections between the intercepting sewer and the sewers to be intercepted, to be constructed according to the plan accompanying these specifications, so arranged that the ordinary flow of the sewer will be delivered into the lower part of the intercepting sewer through a special inlet, and so that in time of storm the excessive flow of the intercepted sewer may be checked and slightly diverted, losing its accumulated air before entering the main. So much of the flow as cannot enter through the lower outlet will enter at the opening in the top of the intercepting sewer, or will flow on through the extension of the sewer to the canal if the main is already full. The openings at the top of the sewer and the extensions to the canal must be constructed and arranged so as to serve as overflows or vent pipes for the main.

The final specifications will be accompanied with detailed plans showing the precise construction of every part of the work, and it will be required that these plans be followed exactly, unless modified by the engineer in charge of the work.

All material furnished for the work to be of the best quality, subject to rigid inspection and to unquestioned rejection if found to be of inferior quality.

In passing the water-works there is to be inserted between the outer ring and the middle ring of the wall of the sewer a complete water-tight tube of thin boiler iron, securely riveted at its joints and perfectly encased with Portland cement inside and outside; this tube to be continued to such distance as the final plans may

indicate. Such further protection of the water-works will be required as the nature of the case may demand.

All sewers and local drains destroyed or disturbed in the construction of the main sewer to be replaced by such special sewers as may be required for the drainage of the houses which they now serve. Surface water along the lines to be admitted to the intercepting sewer or carried over the surface to the canal or otherwise, as may be indicated by the final plans.

All territory lying between the sewer in Swan street and the Main and Hamburg canal to be furnished with a separate system of sewers delivering into the intercepting sewer by one or more communicating lines, according to the plans furnished herewith.

The outlet of the intercepting sewer near Albany street to be constructed substantially on the inclination, and curves shown in the plan and profile, the outlet being carried to a point in the river where the ordinary velocity is not less than three feet per second; to be protected with stone masonry as shown in the plan of that part of the work.

In all construction near or in connection with the canal, the work will be subject to the requirements of the State Engineer as well as to those of the engineer in charge.

In the construction of work in the streets of the city it will be required that not more than 400 feet of trench be opened in one place at any one time. All excavated material must be handled by derricks or other mechanism, so much as is to be removed being dumped directly into carts, and so much as is required to cover the finished structure being deposited directly thereon. No deposit of material on the surface of the street will be permitted.

NEWPORT, R. I., Aug. 17, 1882.

GEO. E. WARING, JR.



Gaylord

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